Hydrogen Technology and Energy Curriculum (HyTEC)

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Project ID #ED5

HyTEC Collaborators

Lawrence Hall of Science
University of California, Berkeley

SCHATZ ENERGY RESEARCH CENTER

AC TRANSIT

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Overview

- **Timeline**
  - September 1, 2004
  - August 31, 2005
  - 20% complete
  - Extension planned
- **Budget**

Total five year: $3,015,955
DOE share: $2,399,150
Contractor share $616,805
Funding FY04: 410,395
DOE share: $324,983
Contractor share: $ 85,412
Funding FY05: none

- **Barriers addressed**
  - Lack of Awareness
  - Institutional Barriers and Access to Audiences
- **Partners**
  - SERC, Humboldt State
  - AC Transit
  - Chabot Space & Science Center
  - NHA
  - Lab-Aids, Inc.

Goal

- Educate high school students and their teachers about the
  - Scientific and technological basis for hydrogen and fuel cells
  - Research and development currently underway to implement safe and cost-effective hydrogen and fuel cell transportation demonstration programs
  - Current challenges to and potential promise of a hydrogen economy in the broader context of energy use and resources.

Goal

- Develop and evaluate a comprehensive and sustainable program of high school curriculum materials and teacher professional development and to disseminate these materials to a large, national audience of students and teachers.
- We propose to do this through our existing instructional materials development approach and network of schools and districts throughout the U.S. that use SEPUP/LHS materials.

Objectives

- Develop, field test in national centers, revise, publish, and disseminate three curriculum modules and integrate hydrogen and fuel cells into existing LHS high school materials.
- Develop and implement a professional development plan for teachers who will use the materials.
- Develop a model for collaboration among school districts, informal science centers, university scientists, local transportation agencies, and other leaders in the field.
- Disseminate the materials to a broad national audience.
- Evaluate the quality and effectiveness of the curriculum materials and professional development strategies.

Objectives: The Curriculum Envisioned

- Part of the SEPUP module series developed at UC Berkeley's Lawrence Hall of Science
  - Twelve modules currently available
  - Recognized for balanced treatment of issues
  - Marketed nationally by Lab-Aids, Inc.
  - Disseminated through numerous national, state, and regional workshops/presentations
  - Used with pre-service teachers in many schools of education
- Integrated into SEPUP's 2-year high school science program (funded by NSF)

Objective:
A SEPUP Instructional Module

Hazardous Materials Investigations Module

- Complete materials kit
  - Equipment
  - Consumables (chemicals)
  - Transparencies
- Teacher's Guide
  - Student Masters
  - Transparency Masters
  - CD of test and masters
- Web site for support, links to other resources, extensions

Example module: Investigating Energy From the Sun

Objectives: Year One

The plan has been modified to fit the greatly reduced funding level and uncertainty of future funding

- Prepare a draft of one module that includes the most important ideas related to hydrogen and fuel cells
  - Related to National Science Education Standards and other standards
  - Able to fit into a typical high school chemistry and/or physical science course
- Pilot the module in classrooms
- Revise to prepare a version for piloting by expert teachers

Approach

- Draft module outline prepared by developers
- Teachers, curriculum developers, and scientists on the team review and revise
- Draft core activities & assessments, develop kit materials, including student fuel cell
- Review of activities by teacher advisors
- Pilot by developers working in San Francisco Bay Area classrooms
- Collect teacher, student, and expert feedback
- Revise based on feedback

Approach, continued

- Team science centers, scientists, and schools to create a collaborative model for hydrogen and fuel cell education
- Include Stack-in-a-Box® activities facilitated by scientists, science center personnel, or participating teachers:
  - illustrate the use of fuel cells for real energy needs
  - investigate additional scientific concepts

Progress

- Completed outline (15 activities) reviewed by team
- Outline correlated to National Science Education Standards
- Prepared with input of high school chemistry and physical science teachers who know what teachers teach and are likely to use
- Prototype kit materials (student fuel cell)
- Pilot testing of selected activities in Berkeley Unified School District
- Focus on solving technical problems

Progress: Module outline example

Activity Title	Summary	National Science Education Standards
3. Using Hydrogen Fuel Cells	Students use a fuel cell to power a small motor. Students measure the mass the fuel cell can lift (mechanical work) or use multimeters to measure the fuel cell output.	5B4d: Most observable forces may be traced to electric forces acting between atoms and molecules. 5E2b: Science often advances with the introduction of new technologies.

Progress: Activity 3

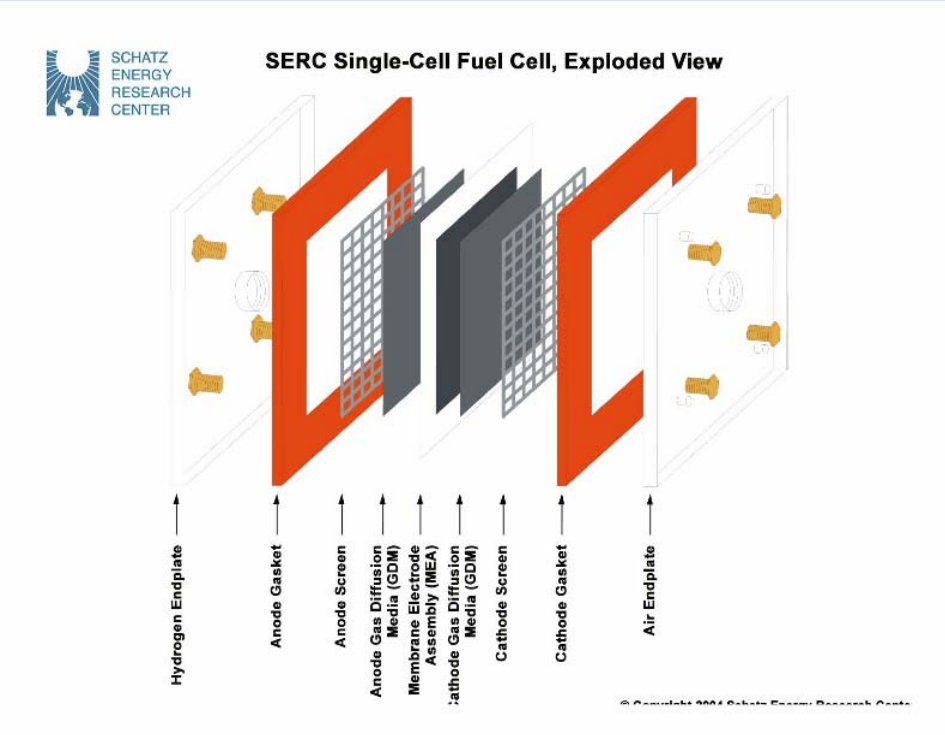
Activity materials:

- Fuel cell
- Separate electrolyzer
- Motor
- Weights

Progress

- Students working with SERC hydrogen fuel cells
- Challenge is to bring eight fuel cells to a high school classroom at reasonable cost

Student fuel cells



- One large fuel cell to be disassembled to study components
- Eight scaled down, operable student fuel cells
  - Not to be disassembled
  - Durable

Stack-in-a-Box® Investigations

- In these photos, students and teachers use the Stack-in-a-Box®
- A Stack-in-a-Box® is in production for use by the Lawrence Hall of Science and in SF Bay Area classrooms

Future work

With current funding:

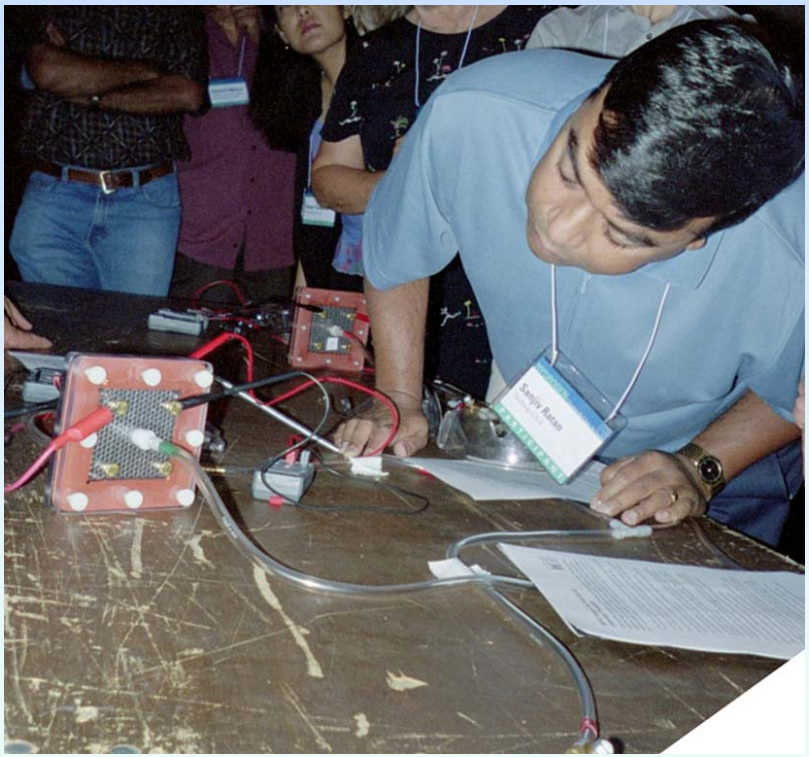
- 2004–2005 school year
  - Complete student fuel cell and kit prototypes
  - Pilot activities in Berkeley classrooms
- Summer
  - Completion of trial unit, with complete activities
  - Review and evaluation by team and external reviewers
- 2005–2006 school year
  - Classroom trial of complete unit and Stack
  - Revision based on feedback
  - Prepare an online field trip to a hydrogen fueling station and fuel cell bus facility

Future work

With continuing funding:

- Expansion of program to three modules, for physical science and chemistry classes
- National field testing with diverse student populations, in a variety of sites
- Stack-in-a-Box® unit for each national field test site
- Professional development program, building on LHS, SERC, and CS&SC experience
- Commercial publication of module with kit
- Dissemination through LHS and established publisher network, catalog, and sales team

Future work



- A student fuel cell in use at a teacher workshop
- Future work will reach a large, national audience of teachers through networks of LHS, CS&SC

Hydrogen Safety

- The most significant hydrogen hazard associated with this project is:

  The release of hydrogen from the

  Stack-in-a-Box® fuel cell system and the resulting combustion of the gas.

Hydrogen Safety

Our approach to deal with this hazard is:

- Standard classroom safety procedures, with detailed safety information in the Teacher's Guide and on Student Sheets
- Use of the Stack-in-a-Box® fuel cell only for demonstrations by the teacher or with guided teacher supervision
- Use of the Stack-in-a-Box® fuel cell only in well ventilated areas
- Small volume of stored hydrogen (4 grams = 1 tablespoon of gasoline energy equivalent)
- Employ standard safety features, including pressure relief and pressure regulation
- High pressure gas is contained within a DOT approved gas cylinder